Ministry of Education and Science of Ukraine
V. N. Karazin Kharkiv National University

**APPROVED BY**
Deputy Chairperson of the Admission Committee
Vice-rector of V. N. Karazin Kharkiv National University
_____Oleksandr HOLOVKO

# THE PROGRAMME
# of the oral entrance examination in Mathematics for foreign citizens applying to study on the basis of Complete General Secondary Education

This programme is based on the current programme of external independent evaluation in mathematics.

## THE LIST OF TOPICS COVERED IN THE EXAM

## 1. ARITHMETICS, ALGEBRA AND BASICS OF MATHEMATICAL ANALYSIS

1. Properties of operations with real numbers. Rules for real number comparison.

2. Natural numbers and zero. Divisibility of natural numbers. Divisors and multiples of a natural number. Even and odd numbers. Divisibility rules for numbers 2, 3, 4, 5, 6, 9 and 10. Division with remainder. Prime and composite numbers. Decomposition of a natural number into its prime factors. The greatest common divisor, the least common multiple.

3. Common fractions. Comparison of common fractions. Proper and improper fraction. Integer and fractional part of a number. Basic properties of fractions. Fraction reduction. Arithmetic mean. Basic fraction problems.

4. Rational and irrational numbers, their comparison and operations with these numbers.

5. Definition of percentage. Rules for percentage calculating. Proportions.

6. Powers with natural, integer and rational exponents, their properties. Arithmetic root and its properties.

7. Logarithms and their properties. Basic logarithmic identity.

8. Monomials and polynomials. Operations with them. Formulas of abridged multiplication.

9. Polynomials in one variable. Roots of polynomials. Decomposition of a polynomial into factors.

10. The notion of a function. Methods for specifying a function. Domain and range of a function. Inverse function.

11. Graph of a function. Increasing and decreasing functions. Periodic functions. Even and odd functions.

12. Sufficient condition for a function to be increasing/decreasing on an interval. The concept of extremum of a function. A necessary condition for extremum of a function. Maximum and minimum values of a function on a closed interval.

13. Definitions and basic properties of linear, quadratic, power, exponential, logarithmic, and trigonometric functions.

14. Equations. Solving equations, roots of equations. Equivalent equations. Graph of an equation with two variables.

15. Inequalities. Solving inequalities. Equivalent inequalities.

16. Systems of equations and systems of inequalities. Solving systems. System solutions. Equivalent systems of equations and inequalities.

17. Numerical sequences. Arithmetic and geometric progressions. Formulas for the $n^{\text{th}}$ term and the sum of the first $n$ terms of progressions.

18. Dependence between trigonometric functions of the same angle. Trigonometric functions of sum and difference of two angles. Half and double angle formulas. Trigonometric reduction formulas.

19. Definition of the derivative, its mechanical and geometric interpretation.

20. Derivative of a sum, difference, product, and quotient. Table of derivatives. Chain rule.

21. Antiderivative and definite integral. Table of antiderivatives. Rules for finding antiderivatives. Newton-Leibniz formula.

22. Permutations (without repetitions), number of permutations. Variations (without repetitions), number of variations. Combinations (without repetitions).

23. Simplest cases for calculating probabilities of random events.

24. Statistical characteristics of datasets.

## II. GEOMETRY

1. Line, ray, line segment, broken line. Length of a line segment. Angle, value of an angle. Vertical and adjacent angles. Parallel lines. Equality and similarity of geometric figures. Ratio of the areas of similar figures.

2. Examples of transformation of geometric figures, types of symmetry.

3. Cartesian coordinates. Vectors. Vector operations.

4. Polygons. Vertices, sides, and diagonals of a polygon. Polygons inscribed in a circle and circumscribed around a circle.

5. Triangles. Median, bisector, and altitude of a triangle, their properties. Types of triangles. The relationship between the sides and angles of a right-angled triangle. Law of cosines.

6. Quadrilaterals: parallelogram, rectangle, rhombus, square, trapezoid; their properties.

7. Circles and disks. Centre, diameter, radius, chord, secant. Line segment relationships in circles. Tangent lines to circles. Circular arcs. Sectors and segments.

8. Central and inscribed angles, their properties.

9. Formulas for the areas of geometric figures: triangle, parallelogram, rectangle, rhombus, square, trapezoid.

10. Circumference of a circle. Length of a circular arc. Radian measure of an angle. Area enclosed by a circle. Area of a circular sector.

11. Plane. Parallel planes and intersecting planes.

12. Parallel line and plane.

13. Angle between a line and a plane. Line perpendicular to a plane.

14. Dihedral angles. Linear angle of a dihedral angle. Perpendicular planes.

15. Polyhedra. Vertices, edges, and faces of a polyhedron. Right and oblique prisms. Pyramids. Right pyramids. Parallelepipeds, their types.

16. Solids and surfaces of revolution. Cylinders, cones, spheres, and balls. Centre, diameter, and radius of a sphere and a ball. Planes tangent to a sphere.

17. Formulas for surface areas and volumes of prisms, pyramids, cylinders, and cones.

18. Formulas for the surface area of a sphere and the volume of a ball.

## Exam structure

The exam task consists of two parts.

The first part contains 3 tasks on the following topics:

- solving linear equations;

- Conversion of algebraic expressions (open brackets, group, simplify an expression, etc.);

- Percentages and proportions (find the percentage of a given number, a number by its percentage, the percentage expression of one number from another; find the unknown term of a proportion);

- Simplest functions (substitute a numerical value for a function given by a formula; the domain of a function);

- The area of a rectangle and a circle; the surface area and volume of a rectangular prism and a straight circular cylinder (find the area or volume, given the units of measurement);

- Graphs and diagrams (given a function that is defined graphically or tabularly, find the intervals of growth and decline, the points of maximum and minimum of this function, etc.; give an example of a function using the graphical method of defining functions for which the conditions for some values at the points and some intervals of growth and decline are specified; analyze the data presented in the form of a diagram);

- A textual task that may include tasks from previous topics.

The second part contains one more complex task from the listed topics that does not require much time to solve.

Each task is worth a maximum of 8 points.

**Evaluation criteria**

| Content of the assessment | Scores |
|---|---|
| The correct answer is obtained. All key points of the solution are justified. | **8** |
| A logically correct sequence of the solution is provided. Some key points may not be sufficiently justified. Possible minor calculation or transformation errors that do not affect the correctness of the answer. The obtained answer may be incorrect or incomplete. | **6 - 7** |
| A logically correct sequence of the solution is provided. Some key points are insufficiently justified or not justified at all. There may be 1-2 errors or minor miscalculations that slightly affect further solving. The obtained answer may be incorrect, incomplete, or only part of the task is solved correctly. | **4 - 5** |
| Some steps are missing in the correct sequence of solving. Key points are not justified. There may be errors in calculations or transformations that affect further solving. The obtained answer is incomplete or incorrect. | **2 - 3** |
| Only some steps of the solution are present. Key points are not justified. The obtained answer is incorrect, or the task is not fully solved. | **1** |
| The participant did not attempt to solve the task, or the provided notes do not meet the above criteria. | **0** |

The maximum score for all tasks is 32 points.

If an applicant scored less than 5 points, he or she received an unsatisfactory grade.

If the applicant scored at least 5 points, the total score is converted to the scale of 100-200 according to the table of the Ukrainian Center for Educational Quality Assessment on the conversion of test scores in mathematics of the national multi-subject test to a scale of 100-200.

Head of the Subject
Examination committee
and Mathematics interview commission _____ Irina ZHOVTONIZHKO

Approved at the meeting of the Admission Committee
of V. N. Karazin Kharkiv National University,

Meeting Minutes № 2 of March 20, 2025

Secretary of
the Admission committee _____ Hanna ZUBENKO